METHOD AND APPARATUS FOR SENSING SEAT OCCUPANT WEIGHT

RELATED APPLICATION

This application claims priority to provisional application 60/120,637 filed on February 24, 1999.

BACKGROUND OF THE INVENTION

1. Field of the Invention.

This invention relates to a method and apparatus for measuring the weight of a seat occupant. Specifically, a sensor arrangement is mounted within a vehicle seat track to provide accurate seat occupant weight measurements.

2. Related Art.

Most vehicles include airbags and seatbelt restraint systems that work together to protect the driver and passengers from experiencing serious injuries due to a high speed collision. It is important to control the deployment force of the airbags and the force of the seatbelt pretensioners based on the size of the driver or the passenger. One way to control these forces is to monitor the weight of the seat occupant. If a smaller person such as a child or infant in a car seat is in the passenger seat, the weight on the seat will be less than if an adult occupies the seat.

Current systems for measuring the weight of a seat occupant are complex and expensive. One type of system uses pressure sensitive foil mats mounted within the seat bottom foam. Another system uses sensors placed at a plurality of locations

within the seat bottom. The combined output from the mats or the sensors is used to determine the weight of the seat occupant. These sensors experience a substantially vertical force, due to the weight of the seat occupant, but are also subject to longitudinal and lateral forces caused by acceleration, deceleration, or turning. The lateral and longitudinal forces picked up by the sensor incorporate an error component into the weight measurement. The sensors are very sophisticated using multiple strain gages and complicated bending elements to provide high measurement sensitivity in the vertical direction and low sensitivity to lateral and longitudinal forces in order to increase accuracy.

Mounting these sensors within the seat bottom can also be difficult and time consuming. It is difficult to find mounting locations for each the sensors that will accommodate all of the various positions of a seated occupant while still providing accurate measurements. Further, shifting of the occupant on the seat can dislodge or move the sensors out of their proper location. Because the sensors are mounted within the seat bottom, it is difficult to reposition the sensors after the seat is installed in the vehicle.

Thus, it is desirable to have a simplified seat occupant weight measurement system that is accurate and easily to install and overcomes the above references deficiencies with prior art systems.

SUMMARY OF THE INVENTION

In a disclosed embodiment of this invention, a system for measuring the weight

of an occupant seated on a vehicle seat includes a track assembly that is used to support a vehicle seat. The track assembly includes a first track mounted to a vehicle structure and a second track supported for movement relative to the first track. The tracks are deflectable in a vertical direction due to an occupant weight force exerted on the seat. At least one sensor is mounted on the tracks for generating a signal representative of the occupant weight force.

In a preferred embodiment, the track assembly is comprised of an inboard track assembly and an outboard track assembly spaced apart from the inboard track assembly. A first sensor assembly is mounted to the inboard track assembly for generating a first signal in response to measuring deflection of the inboard track assembly due to seat occupant weight. A second sensor assembly is mounted to the outboard track assembly for generating a second signal in response to measuring deflection of the outboard track assembly due to seat occupant weight. The system uses a central processor to determine seat occupant weight based on the first and second signals. The system also preferably includes an airbag control module that is in communication with the processor. Deployment force of an airbag is controlled by the control module based on seat occupant weight.

A method for determining the weight of a seat occupant includes the following steps. An inboard seat track assembly is mounted to a vehicle structure and an outboard seat track assembly is spaced apart from the inboard seat track assembly and mounted to the vehicle structure. The inboard and outboard seat track assemblies are defined by a predetermined cross-sectional area and each track assembly has at least

one track segment with a cross-sectional area that is less than the predetermined cross-sectional area. The method steps includes mounting a first sensor assembly in the track segment of the inboard seat track assembly, mounting a second sensor assembly in the track segment of the outboard seat track assembly, generating a first signal from the first sensor assembly in response to deflection of the inboard track assembly due to seat occupant weight, generating a second signal from the second sensor assembly in response to deflection of the outboard track assembly due to seat occupant weight, and combining the first and second signals to determine seat occupant weight.

Additional steps include providing a system controller for controlling deployment of an airbag and generating a seat occupant weight signal based on the combination of the first and second signal. The seat occupant weight signal is transmitted to the controller and the deployment force of the airbag is controlled based on the seat occupant weight.

These and other features of the present invention can be best understood from the following specification and drawings, the following of which is a brief description.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a perspective view showing a vehicle with an airbag system and an occupant sitting in a seat with the airbag in an active state shown in dashed lines.

Figure 2 is a side view of a seat assembly incorporating the subject weight measurement system.

Figure 3 is a side view of the seat track assembly of Figure 2.

Figure 3A is a magnified view of the section 3A indicated in Figure 3.

Figure 4 is a cross sectional view of the track assembly taken along lines 4-4 of Figure 3.

Figure 5 is a schematic view of a control system for the subject weight measurement system.

Figure 6 is a schematic view of the sensors mounted within the subject track assembly.

Figure 7 is a schematic view representing a full bending bridge.

Figure 8 is a schematic view of the sensors mounted within the subject track assembly having an overload mechanism.

DETAILED DESCRIPTION OF AN EXEMPLARY EMBODIMENT

A vehicle includes a vehicle seat assembly, shown generally at 12 in Figure 1, and an airbag system 14. The seat assembly 12 can be either a driver or passenger seat and includes a seat back 16 and a seat bottom 18. When a vehicle occupant 20 is seated on the seat 12 a vertical force Fv is exerted against the seat bottom 18. The vertical force Fv represents the weight of the seat occupant 20.

The airbag system 14 deploys an airbag 24 under certain collision conditions. The deployment force for the airbag 24, shown in dashed lines in Figure 1, varies according to the weight of the occupant 20. The vehicle includes a unique system for measuring the weight of the seat occupant 20. This unique system is installed within a seat track assembly, generally indicated at 26 in Figure 2.

The seat track assembly 26 includes a first track member 28 mounted to a vehicle structure 30 such as a floor, frame, or riser, for example. A second track member 32 is supported for movement relative to the first track member 28 along a longitudinal axis 34. First 38 and second sensors 40 are mounted on one of the track members 28, 32. The sensors 38 and 40 are used to generate a signal representative of the occupant weight. The first sensor 38 is preferably positioned rearwardly and the second sensor 40 positioned forwardly on the track assembly 26. The first 38 and second 40 sensors are used to measure deflection of the track assembly 26 to generate the signal.

The first track member 28 includes a forward end 42 and a rearward end 44 with a central track portion 46 extending between the ends 42, 44. The forward 42 and rearward 44 ends are mounted to the vehicle structure 30 such that the central track portion 46 remains unsupported to form gap 48 between the vehicle structure 30 and the central track portion 46. Preferably, the first track member 28 is mounted to a riser 50 having upwardly extending supports 52 at each end for attachment to the forward 42 and rearward 44 ends of the first track member 28.

Thus, the central track portion 46 of the seat track assembly 26 is deflectable under load. When the occupant is seated on the seat 12, a vertical force Fv is exerted against the track assembly 26, as shown in Figure 3. Reaction forces Fr are exerted in the opposite direction. The forces cause the central track portion 46 to deflect and reflect full bending beam behavior, shown generally at 54 in Figure 3A. The sensors are preferably strain gages 38, 40 that are positioned along the central track portion 46,

however, other types of sensors known in the art could also be used. For example, fiber optic or magneto elastic sensors could be used.

The sensors 38, 40 are preferably positioned in the first track member 28 such that the sensors 38, 40 remain positioned in the unsupported track section as the second track member 32 adjusts horizontally along axis 34. As shown in Figure 4, a plurality of ball bearings 56 are installed between the track members 28, 32 such that the second track member 32 can slide easily relative to the first track member 28. The bearings 56 also transfer the forces applied to the second track member 32 to the rigid track portion 46 between the two (2) sensor locations.

As shown in Figure 5, the seat 12 is mounted to the vehicle structure 30 on an inboard track assembly 26a and an outboard track assembly 26b that is spaced apart from the inboard track assembly 26a by a predetermined distance. The inboard 26a and outboard 26b track assemblies are mounted to have similar bending behavior, i.e. both track assemblies 26a, 26b are deflectable in a vertical direction due to an occupant weight force. Both the inboard 26a and outboard 26b track assemblies include first 28 and second 32 track members.

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In one embodiment, first 28 and second 32 sensors are installed in the inboard track assembly 26a and third 58 and fourth 60 sensors are installed in the outboard track assembly 26b. The first 38 and second 40 sensors generate a first signal 62 representative of the portion of occupant weight on the inboard track assembly 26a and the third 58 and fourth 60 sensors generate a second signal 64 representative of the portion of occupant weight on the outboard track assembly 26b. The signals 62, 64 are

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transmitted to an electronic control unit (ECU) 66, which combines the signals to determine the weight of the occupant 20. The ECU then sends a control signal 68 to a system controller 70. Preferably, the system controller 70 is an airbag control module that is in communication with the ECU 66 such that the deployment force of the airbag 24 is controlled based on seat occupant weight. The system controller 70 could also be used to control the force of seat belt pretensioners based on occupant weight.

While the above configuration is preferred, an option configuration could utilize one sensor assembly mounted to the inboard track assembly for generating the first signal 62 in response to measuring deflection of the inboard track assembly 26a due to seat occupant weight and a second sensor assembly mounted to the outboard track assembly 26b for generating the second 64 signal in response to measuring deflection of the outboard track assembly 26b due to seat occupant weight.

As shown in greater detail in Figures 6, the track assembly 26 has a predetermined cross-sectional area defined by height H1. A portion, generally indicated at 72, of each track assembly 26 has a cross-sectional area defined by H2 that is less than the predetermined cross-sectional area H1. Each track assembly 26a, 26b has two (2) track portions 72 with this decreased cross-sectional area. One sensor assembly 38, 40, 58, 60 is mounted in each track portion 72. Only the first sensor assembly 38 is shown in Figure 6. As the track assembly 26 deflects under load, the sensor assembly 38 measures full bending beam behavior 54, shown in Figure 7. Each of the sensors 38, 40, 58, 60 at the four (4) locations thus serves as a Wheatstone

Bridge for measuring deflection. The operation of a Wheatstone Bridge is well known in the art.

Preferably, the reduced cross-sectional area track portions 72 are created by forming square shaped holes within the first track member 28. The holes create dual-beam spring elements. With such elements located on the inboard 26a and outboard 26b track assemblies, it is possible to measure the vertical force Fv applied on the area between the two sets of tracks 26a, 26b.

The method for determining the weight of a seat occupant includes the following steps. An inboard seat track assembly 26a is mounted to a vehicle structure 30 and an outboard seat track assembly 26b is spaced apart from the inboard seat track assembly 26a and mounted to the vehicle structure 30. The inboard 26a and outboard 26b seat track assemblies are defined by a predetermined cross-sectional area H1 and each track assembly 26a, 26b has at least one track segment 72 with a cross-sectional area H2 that is less than the predetermined cross-sectional area H1. The method steps include mounting a first sensor assembly in the track segment 72 of the inboard seat track assembly 26a and mounting a second sensor assembly in the track segment 72 of the outboard seat track assembly 26b. A first signal 62 is generated from the first sensor assembly in response to deflection of the inboard track assembly 26a due to seat occupant weight. A second signal 64 is generated from the second sensor assembly in response to deflection of the outboard track assembly 26b due to seat occupant weight. The first 62 and second 64 signals are used to determine seat occupant weight.

Additional steps include providing a system controller 70 for controlling

deployment of an airbag 24 and generating a seat occupant weight signal 68 based on the combination of the first 62 and second 64 signals. The seat occupant weight signal is transmitted to the controller and the deployment force of the airbag is controlled based on the seat occupant weight.

Other steps include providing the inboard 26a and outboard 26b track assemblies with forward ends 42 and rearward 44 ends interconnected by a center portion 46 and fixing the forward 42 and rearward 44 ends to a vehicle structure 30 such that the center portion 46 of each track assembly 26a, 26b remains unsupported. The track segment 72 is preferably located in the center portion 46.

As discussed above, the first sensor assembly is preferably comprised of first 38 and second 40 sensors that are mounted in the first track member 28 of the inboard track assembly 26a. The second sensor assembly is preferably comprised of third 58 and fourth 60 sensors that are mounted in the first track member 28 of the outboard track assembly 26b.

A seat track assembly 26 with integrated weight sensors 38, 40, 58, 60 is provided to determine the weight of an occupant 20 seated on a vehicle seat 12. It is preferable to integrate the sensors 38, 40, 58, 60 into the seat track assembly 26 because it is a common component for most vehicle seats 12. The subject weight measurement system is easily incorporated into any type of seat track configuration. The weight sensors 38, 40, 58, 60 are mounted within reduced size track segments 72 to measure deflection of the track material caused by the weight of the occupant 72. The measured weight is independent of seat positions and is accurately provided

in various occupant positions on the seat 12.

By measuring the deflection in all four (4) locations in the inboard 26a and outboard 26b track assemblies, it is possible to calculate the occupant weight, which is proportional to the sum of the output of all of the sensors 38, 40, 58, 60. The center of gravity of the upper part of the seat and the occupant can be calculated by subtracting the sum of the sensor signals in the front from the sum of the sensor signals in the rear and dividing the result by the sum of all four (4) signals. The electronics for signal conditioning can be housed within the track assemblies 26a, 26b as is well known in the art.

Under high overload conditions, the track assembly 26 experiences high vertical Fv and horizontal Fh forces. These forces cause the track to experience an overload resultant force Fre that will try to separate the track 26 from the floor 30. In applications, with heavy overload conditions, like seats having integrated or all-belts-to seat configurations, it is beneficial to integrate an active overload protection. One such method of protection utilizes an overload bolt 74, shown in Figure 8, extending through the track members 28, 30 to the vehicle floor 30. Under high vehicle impact forces, the bolt 74 prevents the track assembly 26 from separating from the floor 30. Thus, the reduced cross-sectional areas 72 do not have to sustain the full impact forces.

Although a preferred embodiment of this invention has been disclosed, it should be understood that a worker of ordinary skill in the art would recognize many modifications come within the scope of this invention. For that reason, the following claims should be studied to determine the true scope and content of this invention.